CLAIMS

What is claimed is:

1. A screw rotor device for positive displacement of a working fluid, comprising:

a female rotor comprising a major diameter and a helical groove receding from said major diameter, said helical groove comprising a bottom land situated between a leading side and a trailing side, said leading side and said trailing side respectively comprising a leading ridge and a trailing ridge at said major diameter; and

a male rotor comprising a minor diameter and a helical thread extending from said minor diameter and rotatably intermeshing in phase with said helical groove, said helical thread comprising a top land situated between a leading face and a trailing face, said leading face and said trailing face comprising a leading edge and a trailing edge, respectively, wherein said top land is in a first sealing relationship with said bottom land, wherein said trailing face is in a second sealing relationship with said trailing ridge, wherein said trailing edge is in a third sealing relationship with said trailing side, and wherein a cross-sectional profile of said helical thread is comprised of a top land line between a leading line and a trailing line, said leading line and said trailing line being selected from a group consisting of a concave line, a straight line, a convex line, and any combination thereof.

2. The screw rotor device according to claim 1, further comprising a housing enclosing said female rotor and said male rotor, said housing comprising a front side, a back side, a first end, a second end, an inlet port, an outlet port, and a pair of cylindrical bores extending between said first end and said second end along a length of said front side and said back side, said pair of cylindrical bores comprising a front cusp extending along said length of said front side and a back cusp extending along said length of said back side of said housing, wherein said leading face is in a fourth sealing relationship with said leading ridge, wherein said leading edge is in a fifth sealing relationship with said leading side, wherein said trailing ridge and said trailing edge are in a sixth

sealing relationship with each other and with said front cusp, and wherein said leading ridge and said leading edge are in a seventh sealing relationship with each other and with said back cusp.

3. The screw rotor device according to claim 2, wherein said major diameter of said female rotor is in an eighth sealing relationship with one of said pair of cylindrical bores, wherein said top land of said thread is in a ninth sealing relationship with another of said pair of cylindrical bores, and wherein said major diameter of said female rotor is in a tenth sealing relationship with said minor diameter of said male rotor, and wherein said major diameter of said female rotor is approximately equal to said minor diameter of said male rotor.

4. The screw rotor device according to claim 3, wherein said first sealing relationship comprises a center, intermeshing sealing area (defined by geometries of said top land and said bottom land), wherein said second sealing relationship comprises a front, outer sealing line (defined by geometries of said trailing face and said trailing ridge), wherein said third sealing relationship comprises a front, inner sealing line (defined by geometries of said trailing edge and said trailing side), wherein said fourth sealing relationship comprises a back, outer sealing line (defined by geometries of said leading face and said leading ridge), wherein said fifth sealing relationship comprises a back, inner sealing line (defined by geometries of said leading edge and said leading side), wherein said front, outer sealing line and said front, inner sealing line define boundaries of a front, intermeshing sealing area between said trailing face and said trailing side and intersect at a common front sealing point according to said sixth sealing relationship (defined by intersection of trailing edge, trailing ridge and front cusp), wherein said back, outer sealing line and said back, inner sealing line define boundaries of a back, intermeshing sealing area between said leading face and said leading side and intersect at a common back sealing point according to said seventh sealing relationship (defined by intersection of leading edge, leading ridge and back cusp), wherein said eighth sealing relationship comprises a first peripheral sealing area (defined by geometries of female rotor major diameter and said cylindrical bores), wherein said ninth sealing relationship comprises a second peripheral sealing area (defined by geometries of said top land and

said cylindrical bores), and wherein said tenth sealing relationship comprises a center, non-meshing sealing area (defined by geometries of said female rotor major diameter and said male rotor minor diameter).

5. The screw rotor device according to claim 3, wherein said female rotor and said male rotor further comprise a plurality of grooves and threads, said plurality of grooves and threads being identical in number and intermeshing in phase with each other, wherein said cross-sectional profile of said male rotor further comprises a tooth, an adjacent tooth, and a toothless sector between said tooth and said adjacent tooth, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle proportional to said first arc angle by a phase-offset multiplier, wherein said phase-offset multiplier is at least one, and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

6. A screw rotor device for positive displacement of a working fluid, comprising:

a female rotor comprising a major diameter and a helical groove receding from said major diameter, said helical groove comprising a bottom land situated between a leading side and a trailing side, said leading side and said trailing side respectively comprising a leading ridge and a trailing ridge at said major diameter; and

a male rotor comprising a minor diameter and a helical thread extending from said minor diameter and rotatably intermeshing in phase with said helical groove, said helical thread comprising a top land situated between a leading face and a trailing face, said leading face and said trailing face comprising a leading edge and a trailing edge, respectively, wherein said top land is in a first sealing relationship with said bottom land, wherein said trailing face is in a second sealing relationship with said trailing ridge, wherein said trailing edge is in a third sealing relationship with said trailing side, wherein said leading face is in a fourth sealing relationship with said leading ridge, and wherein said leading edge is in a fifth sealing relationship with said leading side.

7. The screw rotor device according to claim 6, further comprising a housing enclosing said female rotor and said male rotor, said housing comprising a front side, a back side, a first end, a second end, an inlet port, an outlet port, and a pair of cylindrical bores extending between said first end and said second end along a length of said front side and said back side, said pair of cylindrical bores comprising a front cusp extending along said length of said front side and a back cusp extending along said length of said back side of said housing, wherein said trailing ridge and said trailing edge are in a sixth sealing relationship with each other and with said front cusp, wherein said leading ridge and said leading edge are in a seventh sealing relationship with each other and with said back cusp, wherein said major diameter of said female rotor is in an eighth sealing relationship with one of said pair of cylindrical bores, wherein said top land of said thread is in a ninth sealing relationship with another of said pair of cylindrical bores, and wherein said female rotor major diameter is in a tenth sealing relationship with said male rotor minor diameter.

8. The screw rotor device according to claim 7, wherein said first sealing relationship comprises a center, intermeshing sealing area (defined by geometries of said top land and said bottom land), wherein said second sealing relationship comprises a front, outer sealing line (defined by geometries of said trailing face and said trailing ridge), wherein said third sealing relationship comprises a front, inner sealing line (defined by geometries of said trailing edge and said trailing side), wherein said fourth sealing relationship comprises a back, outer sealing line (defined by geometries of said leading face and said leading ridge), wherein said fifth sealing relationship comprises a back, inner sealing line (defined by geometries of said leading edge and said leading side), wherein said front, outer sealing line and said front, inner sealing line define boundaries of a front, intermeshing sealing area between said trailing face and said trailing side and intersect at a common front sealing point according to said sixth sealing relationship (defined by intersection of trailing edge, trailing ridge and front cusp), wherein said back, outer sealing line and said back, inner sealing line define boundaries of a back, intermeshing sealing area between said leading face and said leading side and intersect at a common back sealing point according to

said seventh sealing relationship (defined by intersection of leading edge, leading ridge and back cusp), wherein said eighth sealing relationship comprises a first peripheral sealing area (defined by geometries of female rotor major diameter and said cylindrical bores), wherein said ninth sealing relationship comprises a second peripheral sealing area (defined by geometries of said top land and said cylindrical bores), and wherein said tenth sealing relationship comprises a center, non-meshing sealing area (defined by geometries of said female rotor major diameter and said male rotor minor diameter).

9. The screw rotor device according to claim 7, wherein said female rotor and said male rotor further comprise a plurality of grooves and threads, said plurality of grooves and threads being identical in number and intermeshing in phase with each other, wherein a cross-sectional profile of said male rotor comprises a tooth, an adjacent tooth, and a toothless sector between said tooth and said adjacent tooth, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle proportional to said first arc angle by a phase-offset multiplier, wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

10. The screw rotor device according to claim 7, further comprising a valve in communication with said outlet port, wherein said helical thread intermeshes with said helical groove in a double-sided sealing relationship, said double-sided sealing relationship defined by said first sealing relationship, said second sealing relationship, said third sealing relationship, said fourth sealing relationship, and said fifth sealing relationship, wherein a leak pathway is not provided through said double-sided sealing relationship, said leak pathway being any stream tube between said male rotor and said female rotor, extending from said front side to said back side and formed by set of continuous gaps with an effective diameter exceeding an order of magnitude greater than a sealing tolerance, wherein said helical thread intermeshes with said helical groove on said front side in close proximity to said front cusp such that a front blow hole is not provided between said helical

thread, said helical groove and said front cusp, wherein said helical thread intermeshes with said helical groove on said back side in close proximity to said back cusp wherein a back blow hole is not provided between said helical thread, said helical groove and said back cusp, and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%..

11. A screw rotor product for positive displacement of a working fluid, comprising:

a housing comprising a first end, a second end, an inlet port, an outlet port, and a pair of cylindrical bores extending between said first end and said second end, said pair of cylindrical bores comprising a front cusp extending along a length of a front side of said housing and a back cusp extending along a length of a back side of said housing;

a female rotor comprising a major diameter and a helical groove receding from said major diameter, said helical groove comprising a bottom land situated between a leading side and a trailing side, said female rotor being rotatably mounted in said housing with said major diameter in close tolerance with one of said pair of cylindrical bores to form a first peripheral sealing area; and

a male rotor comprising a minor diameter and a helical thread extending from said minor diameter, said male rotor rotatably mounted in said housing, said helical thread comprising a top land situated between a leading face and a trailing face, a cross-sectional profile of said helical thread respectively comprising a top land line situated between a leading line and a trailing line, said leading line and said trailing line being selected from a group consisting of a concave line, a straight line, a convex line, and any combination thereof, said top land being in close tolerance with another one of said pair of cylindrical bores to form a second peripheral sealing area, said helical thread intermeshing in phase and in close tolerance with said helical groove to form an intermeshing sealing area, said intermeshing sealing area extending continuously from a back region at a back intersection between said leading face, said leading side, and said back cusp to a front region at a front intersection between said trailing face, said trailing side and said front cusp.

12. The screw rotor device according to claim 11, wherein said back intersection does not include a back blow hole between said helical thread, said helical groove and said back cusp and wherein said front intersection does not include a front blow hole between said helical thread, said helical groove and said front cusp.

13. The screw rotor device according to claim 11, wherein said intermeshing sealing area further comprises a center sealing area between said top land and said bottom land.

14. The screw rotor device according to claim 11, wherein said leading face and said trailing face further comprise a leading edge and a trailing edge, respectively, and wherein said intermeshing sealing area further comprises a leading seal area between said leading edge and said leading side and a trailing seal area between said trailing edge and said trailing side.

15. The screw rotor device according to claim 14, wherein said leading seal area further comprises a leading axial seal between said leading face of said thread and said leading side of said groove.

16. The screw rotor device according to claim 15, wherein said leading side of said groove further comprises a leading ridge at said major diameter of said female rotor and said leading axial seal further comprises a seal between said leading ridge and said leading face.

17. The screw rotor device according to claim 14, wherein said trailing seal area further comprises a trailing axial seal between said trailing face of said thread and said trailing side of said groove, said trailing side of said groove further comprises a trailing ridge at said major diameter of said female rotor, and said trailing axial seal comprises a seal between said trailing ridge and said trailing face.

18. The screw rotor device according to claim 11, wherein said intermeshing sealing area further comprises a leading seal area, a trailing seal area, and a center sealing area connecting said leading seal area to said trailing seal area, wherein said leading face and said trailing face further comprise a leading edge and a trailing edge, respectively, wherein said leading side and said trailing side further comprise a leading ridge and a trailing ridge, respectively, wherein said center

sealing area is formed between said top land and said bottom land, wherein said leading seal area is formed between said leading side and said leading face at a first region defined by said leading edge intersecting with said leading side, at a second region defined by said leading ridge intersecting with said leading face, and at a third region extending between said first region and said second region, and wherein said trailing seal area is formed between said trailing face and said trailing side.

19. The screw rotor device according to claim 18, wherein said trailing seal area comprises a first trailing region defined by said trailing edge intersecting said trailing side, a second trailing region defined by said leading ridge intersecting with said leading face, and a third trailing region extending between said first trailing region and said second trailing region.

20. The screw rotor device according to claim 18, wherein said female rotor and said male rotor further comprise a plurality of grooves and threads, respectively, said plurality of grooves and threads being identical in number and intermeshing in phase with each other, wherein a cross-sectional profile of said male rotor comprises a tooth, an adjacent tooth, and a toothless sector between said tooth and said adjacent tooth, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle proportional to said first arc angle by a phase-offset multiplier.

21. The screw rotor device according to claim 11, wherein said female rotor and said male rotor each further comprise an axis of rotation centrally located within one of said pair of cylindrical bores, wherein said major diameter of said female rotor rotates in close tolerance to said minor diameter of said male rotor to form a center, non-meshing sealing area therebetween, and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

22. The screw rotor device of claim 21, further comprising a valve in communication with said outlet port, wherein said center, non-meshing sealing area and said intermeshing sealing area

are joined to form a continuous seal extending from said first end of said housing to said second end of said housing and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 90%.

23. The screw rotor device according to claim 21, wherein said top land line is comprised of an arc and wherein said geometrical line pairs are asymmetric about a center point of said arc.

24. The screw rotor device according to claim 21, wherein a cross-sectional profile of said helical groove comprises a bottom land line situated between a pair of lines selected from a group consisting of a concave line, a straight line, a convex line, and any combination thereof.

25. The screw rotor device according to claim 24, wherein one of said pair of lines is radially aligned with said axis of rotation for said female rotor.

26. The screw rotor device according to claim 21, wherein said female rotor and said male rotor further comprise a plurality of grooves and threads, respectively, said plurality of grooves and threads being identical in number and intermeshing in phase and in close tolerances with each other.

27. The screw rotor device according to claim 26, wherein a cross-sectional profile of said male rotor comprises a tooth, an adjacent tooth, and a toothless sector between said tooth and said adjacent tooth, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle proportional to said first arc angle by a phase-offset multiplier.

28. The screw rotor device according to claim 26, wherein said close tolerances between said grooves and said threads are within a same order of magnitude as at least one of said close tolerance between said female rotor and said housing and said close tolerance between said male rotor and said housing.

29. The screw rotor device according to claim 26, wherein said close tolerances between said grooves and said threads is no greater than at least one of said close tolerance between said female rotor and said housing and said close tolerance between said male rotor and said housing.

30. The screw rotor device according to claim 26, further comprising a recirculation path for the working fluid from said outlet port to said inlet port and external to the positive displacement of the working fluid between said inlet port and said outlet port within said housing,.

31. A screw rotor system for positive displacement of a working fluid, comprising:

a housing comprising a first end, a second end, an inlet port, an outlet port, and a pair of cylindrical bores extending between said first end and said second end, said pair of cylindrical bores comprising a first cusp extending along a length of a first side of said housing and a second cusp extending along a length of a second side of said housing;

a female rotor comprising a major diameter and a helical groove receding from said major diameter, said helical groove comprising a bottom land situated between a leading side and a trailing side, said leading side and said trailing side comprising a leading ridge and a trailing ridge at said major diameter, said major diameter being in a first sealing relationship with one of said pair of cylindrical bores; and

a male rotor comprising a minor diameter and a helical thread extending from said minor diameter and rotatably intermeshing in phase with said helical groove within said housing, said minor diameter being in a second sealing relationship with said major diameter of said female rotor, said helical thread comprising a top land in a third sealing relationship with another of said pair of cylindrical bores, wherein said top land is also in a fourth sealing relationship with said bottom land, said top land being situated between a leading face and a trailing face, said trailing face being in a fifth sealing relationship with said trailing ridge, said trailing face further comprising a trailing edge in a sixth sealing relationship with said trailing side, wherein said trailing ridge and said trailing edge are in a seventh sealing relationship with each other and with said first cusp of said pair of cylindrical bores.

32. The screw rotor device according to claim 31, wherein said leading face of said helical thread further comprises a leading edge, said leading face being in an eighth sealing relationship with said leading ridge, said leading edge being in a ninth sealing relationship with said leading

side, and wherein said leading ridge and said leading edge are in a tenth sealing relationship with each other and with said second cusp of said pair of cylindrical bores.

33. The screw rotor device according to claim 32, wherein said female rotor and said male rotor further comprise a pair of ends in an eleventh sealing relationship and a twelfth sealing relationship with said first end and said second end of said housing, respectively.

34. The screw rotor device according to claim 32, wherein said leading edge and said trailing edge of said helical thread respectively define said leading side and said trailing side of said helical groove as said helical thread intermeshes with said helical groove.

35. The screw rotor device according to claim 32, wherein said leading ridge and said trailing ridge of said helical groove respectively define said leading face and said trailing face of said helical thread as said helical thread intermeshes with said helical groove.

36. The screw rotor device according to claim 32, wherein said leading edge and said trailing edge of said helical thread respectively define said leading side and said trailing side of said helical groove as said helical thread intermeshes with said helical groove, and wherein said leading ridge and said trailing ridge of said helical groove respectively define a leading root portion in said leading face and a trailing root portion in said trailing face of said helical thread.

37. The screw rotor device according to claim 31, wherein said sealing relationships each comprise a sealing tolerance defined by a geometric proximity between at least one of said female rotor and said male rotor, said female rotor and said housing, and said male rotor and said housing, and wherein said helical thread and said helical groove bound a space within said cylindrical bores, seal the working fluid within in said housing, and transition between meshing with each other and sealing around said housing while maintaining said sealing of the working fluid in said space.

38. The screw rotor device according to claim 37, wherein said top land of said helical thread separates said leading face from said trailing face by a minimum top land distance and wherein said minimum top land distance is at least an order of magnitude greater than said sealing tolerance between said helical thread and said helical groove.

39. The screw rotor device according to claim 37, wherein said sealing tolerance is no greater than at least one of an order of magnitude greater than said geometric proximity, 0.003" and 1/1,000 of said male rotor diameter.

40. The screw rotor device according to claim 37, wherein said sealing tolerance is no greater than at least one of said geometric proximity, 0.001" and 1/10,000 of said male rotor diameter.

41. The screw rotor device according to claim 37, wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

42. The screw rotor device according to claim 37, wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 90%.

43. The screw rotor device according to claim 37, wherein said helical thread intermeshes with said helical groove in a double sealing relationship wherein a leak pathway is not provided between said male rotor and said female rotor from said first side to said second side of said housing, wherein said leak pathway is a stream tube with an effective diameter greater than said minimum top land distance.

44. The screw rotor device according to claim 37, wherein said first sealing relationship comprises a first peripheral sealing area (defined by geometries of said major diameter and said cylindrical bores), wherein said second sealing relationship comprises a center, non-meshing sealing area (defined by geometries of said major diameter and said minor diameter), wherein said third sealing relationship comprises a second peripheral sealing area (defined by geometries of said top land and said cylindrical bores), wherein said fourth sealing relationship comprises a center, intermeshing sealing area (defined by geometries of said top land and said bottom land), wherein said fifth sealing relationship comprises an outer sealing line (defined by geometries of said trailing face and said trailing ridge), wherein said sixth sealing relationship comprises an inner sealing line (defined by geometries of said trailing edge and said trailing side), wherein said outer

sealing line and said inner sealing line define boundaries of a first intermeshing sealing area between said trailing face and said trailing side and intersect at a common sealing point according to said seventh sealing relationship (defined by intersection of trailing edge, trailing ridge and first cusp).

45. The screw rotor device according to claim 37, wherein said helical thread intermeshes with said helical groove in close proximity to said first cusp in a first triple sealing relationship wherein a blow hole is not provided between said helical thread, said helical groove and said first cusp.

46. The screw rotor device according to claim 45, wherein said helical thread intermeshes with said helical groove in close proximity to said second cusp in a second triple sealing relationship wherein a blow hole is not provided between said helical thread, said helical groove and said second cusp.

47. The screw rotor device according to claim 31, wherein said female rotor and said male rotor further comprise a plurality of grooves and threads, said plurality of grooves and threads being identical in number and intermeshing in phase with each other, wherein a cross-sectional profile of said male rotor comprises a tooth, an adjacent tooth, and a toothless sector between said tooth and said adjacent tooth, said tooth being subtended by a first arc angle and said sector comprising a second arc angle proportional to said first arc angle by a phase-offset multiplier, wherein said first sealing area and said third sealing area extend from said first side of said housing to said second side of said housing, and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

48. The screw rotor device according to claim 47, wherein said phase-offset multiplier is less than one.

49. The screw rotor device according to claim 47, wherein said phase-offset multiplier is at least one.

50. The screw rotor device according to claim 47, wherein said phase-offset multiplier is at least two.

51. The screw rotor device according to claim 47, wherein said phase-offset multiplier is at least three.

52. The screw rotor device according to claim 47, wherein said phase-offset multiplier is at least four.

53. The screw rotor device according to claim 47, further comprising a valve in communication with said outlet port, wherein said cross-sectional profile of said helical thread further comprises a leading root, a trailing root, a leading line extending from said first root to a leading edge point on said leading edge and a trailing line extending from said trailing root to a trailing edge point on said trailing edge, and wherein a cross-sectional profile of said helical groove further comprises a leading flank, a trailing flank, a complementary leading line extending from said leading flank to a leading ridge point on said leading ridge, and a complementary trailing line extending from said trailing flank to a trailing ridge point on said trailing ridge, and wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 90%.

54. The screw rotor device according to claim 53, wherein said thread profile further comprises a leading edge discontinuity at said leading edge point where said leading line and said major diameter arc intersect and further comprises a trailing edge discontinuity at said trailing edge point where said trailing line and said major diameter arc intersect, and wherein said leading line, trailing line, leading complementary line and trailing complementary line are each selected from a group of lines consisting of straight lines, arcs, involutes, inverse-involutes, parabolas, hyperbolas, cycloids, trochoids, epicycloids, epitrochoids, hypocycloids, hypotrochoids, continuous straight lines and arcuate lines, and any combination thereof in piecewise-continuous lines.

55. The screw rotor device according to claim 53, wherein said leading edge point and said trailing edge point of said thread profile respectively define at least a portion of said complementary leading line and said complementary trailing line of said groove profile as said helical groove intermeshes with said helical thread, and wherein said leading ridge point and said trailing ridge point of said groove profile respectively define at least a portion of said leading line and said trailing line of said thread profile as said helical groove intermeshes with said helical thread.

56. The screw rotor device according to claim 55, wherein a non-defined portion of said leading line, said trailing line, said complementary leading line, said complementary trailing line is selected from a group of lines consisting of straight lines, arcs, involutes, inverse-involutes, parabolas, hyperbolas, cycloids, trochoids, epicycloids, epitrochoids, hypocycloids, hypotrochoids, continuous straight lines and arcuate lines, and any combination thereof in piecewise-continuous lines.

57. The screw rotor device according to claim 55, wherein said defined portions of said complementary leading line and said complementary trailing line are continuous arcuate lines extending from said leading ridge point and trailing ridge point to said leading flank and said trailing flank, respectively, and wherein said defined portions of said leading line and trailing line are continuous arcuate lines extending from said leading root and said trailing root to a leading intermediate point and a trailing intermediate point, respectively, said leading intermediate point being a point on said leading line between said leading root and said leading edge point and said trailing intermediate point being a point on said trailing line between said trailing root and said trailing edge point.

58. The screw rotor device according to claim 57, wherein said trailing line further comprises a trailing line segment from said trailing intermediate point to said trailing edge line and wherein said leading line further comprises a leading line segment from said leading intermediate point to said leading edge line, said trailing line segment and leading line segment being defined by points

of proximity to said groove's complementary trailing line and complementary leading line, respectively.

59. The screw rotor device according to claim 31, wherein said outlet port is selected from the group of ports consisting of a circumferential end port, a V-shaped circumferential end port, a triangular side port, and any combination thereof and wherein said inlet port is selected from the groups of ports consisting of a circumferential end port, a W-shaped circumferential end port, a trapezoidal side port, and any combination thereof.

60. The screw rotor device according to claim 31, wherein a cross-sectional profile of said helical groove comprises a bottom land line situated between a pair of lines selected from a group consisting of a convex line, a straight line, a concave line, and any combination thereof, and wherein a cross-sectional profile of said helical thread comprises a top land line situated between a leading line and a trailing line, said leading line and said trailing line being selected from a group consisting of a concave line, a straight line, a convex line, and any combination thereof.

61. A screw rotor product for positive displacement of a working fluid, comprising:

a housing comprising an inlet port at a first end and an outlet port at a second end and a pair of cylindrical bores extending therebetween, said pair of cylindrical bores comprising a front cusp extending along a length of a front side of said housing and a back cusp extending along a length of a back side of said housing;

a female rotor comprising a major diameter and a plurality of helical grooves receding from said major diameter to a bottom land diameter, wherein said female rotor is rotatably mounted within said first end and said second end of said housing and wherein said major diameter is in close tolerance with said housing; and

a male rotor comprising a minor diameter and a plurality of helical threads extending from said minor diameter to a top land diameter, wherein said male rotor is rotatably mounted within first end and second end of said housing and counter-rotates with respect to said female rotor, wherein said top land diameter is in close tolerance with said housing, wherein said plurality of

threads are identical in number with said plurality of grooves and intermesh in phase with each other in a plurality of thread-groove pairs, and wherein said thread-groove pairs bound a plurality of non-communicating spaces within said cylindrical bores, seal the working fluid within in said housing, and transition between meshing with each other and sealing around said housing while maintaining said sealing of the working fluid in said non-communicating spaces.

62. The screw rotor device according to claim 61, wherein each one of said plurality of non-communicating spaces are comprised of a plurality of contiguous boundary areas comprising at least one intermeshing sealing area coterminous with at least one non-meshing sealing area.

63. The screw rotor device according to claim 62, wherein said intermeshing sealing area extends continuously from a back intersection between one of said thread-groove pairs and in close tolerance with said back cusp to a front intersection between said one of thread-groove pairs and said front cusp and wherein said non-meshing sealing area extends from said one of said thread-groove pairs to an adjacent thread-groove pair, said non-meshing sealing area being formed between said major diameter of said female rotor rotating in close tolerance to said minor diameter of said male rotor.

64. The screw rotor device according to claim 63, wherein said intermeshing sealing area is respectively comprised of a leading face and a leading side in said one of said thread-groove pair and a trailing face and a trailing side in said adjacent thread-groove pair.

65. The screw rotor device according to claim 64, wherein at least one of said transition, said non-meshing sealing area, and said intermeshing sealing area further comprises a small gap within an order of magnitude of said close tolerance.

66. The screw rotor device according to claim 64, wherein at least one of said transition, said non-meshing sealing area, and said intermeshing sealing area further comprises a small gap approximately equal to said close tolerance.

67. The screw rotor device according to claim 64, wherein said helical thread and said helical groove intermesh at said inlet port and close off said spaces from said inlet to seal the working fluid in said housing.

68. The screw rotor device according to claim 61, wherein a cross-sectional profile of said male rotor further comprises a tooth, an adjacent tooth and a toothless sector therebetween, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle that is at least twice said first arc angle, wherein said tooth is asymmetric with reference to said first arc angle.

69. The screw rotor device according to claim 68, wherein said toothless sector comprises a second arc angle that is at least thrice said first arc angle.

70. The screw rotor device according to claim 69, wherein said toothless sector comprises a second arc angle that is at least quadruple said first arc angle.

71. The screw rotor device according to claim 61, wherein said helical threads and said helical grooves are comprised of variable-pitch helical threads and variable-pitch helical grooves, respectively, wherein said pitch varies axially with said length of said housing.

72. The screw rotor device according to claim 61, wherein the positive displacement of the working fluid between said inlet port and said outlet port of said housing is produced by said female rotor and said male rotor with a thermodynamic efficiency of at least 85%.

73. The screw rotor device according to claim 61, further comprising a recirculation path for the working fluid from said outlet port to said inlet port and external to the positive displacement of the working fluid between said inlet port and said outlet port within said housing.

74. The screw rotor device according to claim 61, further comprising at least one of another male rotor and another female rotor intermeshing in phase with at least one of said female rotor and said male rotor, respectively.

75. The screw rotor device according to claim 61, further comprising a plurality of screw rotor pairs, wherein each screw rotor pair comprises at least one male rotor and at least one female rotor, and wherein said screw rotor pairs are in fluid communication with each other.

76. The screw rotor device according to claim 75, wherein said screw rotor pairs are a set of positive displacement machines selected from the group consisting of a compressor to compressor set, a compressor to expander set, an expander to compressor set, and an expander to expander set.

77. The screw rotor device according to claim 76, wherein said set of positive displacement machines comprise said male rotor and said female rotor and at least one additional rotor pair, said additional rotor pair comprising an additional male rotor and an additional female rotor selected from the group consisting of a pair of in-phase intermeshing rotors, a pair of offset-thread rotors, a pair of in-phase intermeshing, offset-thread rotors, a pair of Roots-type rotors, a pair of Krigar-type rotors, a pair of Lysholm-type rotors, a pair of scroll rotors, and any equivalent rotor pair.

78. The screw rotor device according to claim 77, further comprising at least one of another male rotor and another female rotor, wherein said another male rotor intermeshes in phase with at least one of said female rotor and said additional female rotor and wherein said another female rotor intermeshes in phase with at least one of said male rotor and said additional male rotor.

79. The screw rotor device according to claim 76, wherein said housing encloses each one of said screw rotor pairs in said set of positive displacement machines.

80. The screw rotor device according to claim 76, further comprising an additional housing enclosing at least one of said screw rotor pairs in said set of positive displacement machines and comprising a fluid conduit for the working fluid between said plurality of screw rotor pairs.

81. The screw rotor device according to claim 80, wherein said fluid conduit further comprises a thermodynamic processor selected from the group consisting of an intercooler, a heat exchanger, a burner section, a bypass section, and any combination thereof.

82. The screw rotor device according to claim 75, wherein said screw rotor pairs further comprise a female rotor shaft for said female rotor and a male rotor shaft for said male rotor.

83. The screw rotor device according to claim 82, wherein said female rotor shaft is unique to said female rotor in each of said screw rotor pairs and wherein said male rotor shaft is unique to said male rotor in each of said screw rotor pairs.

84. The screw rotor device according to claim 82, wherein at least one of said female rotor shaft and said male rotor shaft is a shared shaft selected from the group consisting of a male to male shaft, a male to female shaft, a female to male shaft, and a female to female shaft.

85. The screw rotor device according to claim 75, further comprising at least one of a drive shaft, a power-input shaft, a fluid conduit, a compressed air source, a nozzle, a valve, a fuel inlet, a wheel, and a thermodynamic processor, wherein at least one of said plurality of screw rotor pairs are in at least one of fluid communication and mechanical communication with said drive shaft, said power-input shaft, said fluid conduit, said compressed air source, said nozzle, said valve, said wheel, said fuel inlet, and said thermodynamic processor.

86. The screw rotor device according to claim 85, wherein said plurality of screw rotor pairs are arranged in said at least one fluid communication and mechanical communication with at least one of said drive shaft, said power-input shaft, said fluid conduit, said compressed air source, said nozzle, said valve, said fuel inlet, said wheel, and said thermodynamic processor in a positive displacement machine configuration selected from the group consisting of a compressor, an expander, a motor, a pump, a hydrostatic drive, a hydraulic motor, a shop equipment motor, a positive-drive motor, a hydraulic pump, an internal combustion engine, an axial flow jet engine, and any equivalent rotary piston application.

87. The screw rotor device according to claim 61, further comprising at least one of a drive shaft, a power-input shaft, a fluid conduit, a compressed air source, a nozzle, a valve, a fuel inlet, a wheel, and a thermodynamic processor, wherein at least one of said male rotor and said female rotor is in at least one of fluid communication and mechanical communication with said drive shaft, said power-input shaft, said fluid conduit, said compressed air source, said nozzle, said valve, said fuel inlet, said wheel, and said thermodynamic processor, and wherein a cross-sectional

profile of said male rotor further comprises a tooth, an adjacent tooth and a toothless sector therebetween, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle that is at least twice said first arc angle.

88. The screw rotor device according to claim 87, wherein said female rotor and said male rotor are arranged in said at least one fluid communication and mechanical communication with at least one of said drive shaft, said power-input shaft, said fluid conduit, said compressed air source, said nozzle, said valve, said fuel inlet, said wheel, and said thermodynamic processor in a positive displacement machine configuration selected from the group consisting of a compressor, an expander, a motor, a pump, a hydrostatic drive, a hydraulic motor, a positive-drive motor, a hydraulic pump, an internal combustion engine, an axial flow jet engine, and any equivalent rotary piston application.

89. The screw rotor device according to claim 61, further comprising:

a pressurized driving fluid source;

a fluid conduit in fluid communication between said pressurized driving fluid source and said inlet;

a drive shaft in mechanical communication with at least one of said male rotor and said female rotor; and

at least one of a tool holder, a blade and a wheel operatively connected to said drive shaft.

90. The screw rotor device according to claim 89, wherein at least one of a front blow hole and a back blow hole is not provided between said helical thread, said helical groove, said front cusp, and said back cusp, wherein said pressurized driving fluid source is selected from the group of a compressed air source and a pressurized water source, and wherein said drive shaft is connected to at least one of said blade of a hydrodynamic garbage crusher, said blade of a hydrodynamic watering lawn mower, said tool holder of a milling machine, and said wheel of a hydrostatic drive vehicle.

91. The screw rotor device according to claim 61, wherein at least one of a front blow hole and a back blow hole is not provided between said helical thread, said helical groove, said front cusp, and said back cusp, and wherein said compressed air source is comprised of an additional rotor pair selected from the group consisting of a pair of in-phase intermeshing rotors, a pair of offset-thread rotors, a pair of in-phase intermeshing, offset-thread rotors, a pair of Roots-type rotors, a pair of Krigar-type rotors, a pair of Lysholm-type rotors, a pair of scroll rotors, and any equivalent rotor pair.

92. The screw rotor device according to claim 91, further comprising:

at least one additional rotor pair, said additional rotor pair comprising an additional inlet, an additional outlet, an additional male rotor and an additional female rotor;

a fluid conduit in fluid communication with and between said outlet and said additional inlet; and

at least one thermodynamic processor in fluid communication with at least one of said outlet, said additional rotor pair, and said fluid conduit.

93. The screw rotor device according to claim 92, wherein said at least one rotor pair is a pair of in-phase intermeshing, offset-thread rotors selected from the group consisting of a compressor and an expander, wherein said male rotor is further comprised of a male rotor shaft and wherein said female rotor is comprised of a female rotor shaft, and wherein at least one of said female rotor shaft and said male rotor shaft is a shared shaft with at least one of said additional male rotor and said additional female rotor.

94. The screw rotor device according to claim 91, further comprising:

a burner in fluid communication with said outlet;

an expander in fluid communication with said burner; and

a nozzle in fluid communication with said expander.

95. The screw rotor device according to claim 94, further comprising at least one additional rotor pair selected from the group consisting of a compressor and an expander.

96. The screw rotor device according to claim 91, further comprising:

a fuel inlet in fluid communication with at least one of said non-communicating spaces within said cylindrical bores; and

a valve in communication with at least one of said outlet port and said fuel inlet.

97. The screw rotor device according to claim 96, further comprising at least one additional rotor pair, said additional rotor pair comprising an additional inlet, an additional outlet, an additional male rotor and an additional female rotor, wherein said male rotor is further comprised of a male rotor shaft and wherein said female rotor is comprised of a female rotor shaft, and wherein at least one of said female rotor shaft and said male rotor shaft is a shared shaft with at least one of said additional male rotor and said additional female rotor.

98. The screw rotor device according to claim 96, wherein said helical thread and said helical groove each comprise multiple pitches in said length of said housing.

99. A screw rotor product for positive displacement of a working fluid, comprising:

a housing comprising an inlet port, an outlet port, and a pair of cylindrical bores, said pair of cylindrical bores comprising a front cusp extending along a length of a front side of said housing and a back cusp extending along a length of a back side of said housing;

a female rotor comprising at least one helical groove, wherein said female rotor is rotatably mounted within said housing; and

a male rotor comprising at least one helical thread, wherein said male rotor is rotatably mounted within said housing and counter-rotates with respect to said female rotor, wherein said helical thread intermeshes in phase with said helical groove, and wherein at least one of a front blow hole and a back blow hole is not provided between said helical thread, said helical groove, said front cusp, and said back cusp.

100. The screw rotor product according to claim 99, wherein said helical thread and said helical groove each comprise multiple pitches in said length of said housing

101. The screw rotor device according to claim 99, further comprising:

a pressurized driving fluid source;

a fluid conduit in fluid communication between said driving fluid source and said inlet;

a drive shaft in mechanical communication with at least one of said male rotor and said female rotor; and

at least one of a tool holder, a blade and a wheel operatively connected to said drive shaft.

102. The screw rotor device according to claim 101 wherein said pressurized driving fluid source is selected from the group of a compressed air source and a pressurized water source.

103. The screw rotor device according to claim 102 wherein said drive shaft is connected to at least one of said blade of a hydrodynamic garbage crusher, said blade of a hydrodynamic watering lawn mower, and said tool holder of a milling machine.

104. The screw rotor device according to claim 99, further comprising at least one of a drive shaft, a power-input shaft, a fluid conduit, a compressed air source, a nozzle, a valve, a fuel inlet, a wheel, and a thermodynamic processor, wherein said female rotor and said male rotor are arranged in at least one of a fluid communication and a mechanical communication with at least one of said drive shaft, said power-input shaft, said fluid conduit, said compressed air source, said nozzle, said valve, said fuel inlet, and said thermodynamic processor in a positive displacement machine configuration selected from the group consisting of a compressor, an expander, a motor, a pump, a hydrostatic drive, a hydraulic motor, a positive-drive motor, a hydraulic pump, an internal combustion engine, an axial flow jet engine, and any equivalent rotary piston application, and wherein a cross-sectional profile of said male rotor further comprises a tooth, an adjacent tooth and a toothless sector therebetween, said tooth being subtended by a first arc angle and said toothless sector comprising a second arc angle that is at least twice said first arc angle.

105. A process for designing a screw rotor device, comprising the steps of:

(a) defining a pair of intersecting major circles, said pair of intersecting major circles respectively comprising a pair of centers and a pair of major diameters, wherein each one of said

pair of intersecting major circles only encompasses a respective one of said pair of centers, and wherein said pair of centers are spaced apart less than a sum of one half of said pair of major diameters;

(b) defining a circumferential top land of a tooth situated on one of said pair of intersecting major circles;

(c) identifying a pair of sides radially receding from another of said pair of intersecting major circles to a bottom land, wherein said sides are defined by a first path of said top land when said pair of intersecting major circles rotate in phase with each other by equal angular amounts, wherein said sides comprise a pair of intermediate line segments receding from a pair of circumferential ridges to said bottom land;

(d) identifying a pair of root sections of said tooth, wherein said pair of root sections are respectively defined by a second path of said pair of circumferential ridges when said pair of intersecting major circles rotate in phase with each other by equal angular amounts; and

(e) identifying a pair of extending line segments on said tooth, wherein said extending line segments are defined by a third path of said pair of intermediate line segments when said pair of intersecting major circles rotate in phase with each other by equal angular amounts.

The process according to claim 101, wherein steps (a)-(e) further comprise the steps of:

defining a first rotor major circle, said first rotor major circle comprising a first major diameter;

defining a second rotor major circle intersecting with said first rotor major circle at a pair of intersection points, said second rotor major circle comprising a second major diameter and wherein less than one half of said second major diameter extends into said first rotor major circle and wherein less than one half of said first major diameter extends into said second rotor major circle, wherein said second rotor major circle shares a single tangential point with a first rotor minor circle centered within said first rotor major circle and wherein said first rotor major circle shares another single tangential point with a second rotor minor circle centered within said second

rotor major circle;

selecting a first point on said first rotor major circle;

identifying a first line segment receding radially inward from a second rotor major point to a second rotor minor point, wherein said first line segment is defined by a first path of said first point as it progresses from said second rotor major circle to said second rotor minor circle when said first rotor major circle and said second rotor major circle rotate in phase with each other by equal angular amounts;

selecting a second point on said first rotor major circle, said second point being circumferentially spaced from said first point;

identifying a second line segment receding radially inward from a circumferentially-spaced second rotor major point to a circumferentially-spaced second rotor minor point, wherein said second line segment is defined by a second path by said second point as it progresses from said second rotor major circle to said second rotor minor circle when said first rotor major circle and said second rotor major circle rotate in phase with each other by equal angular amounts, and wherein said circumferentially-spaced second rotor major point and second rotor minor point are circumferentially spaced from said second rotor major point said second rotor minor point, respectively;

identifying a pair of first rotor root line segments extending from said first rotor minor circle to a pair of intermediate points, wherein one of said pair of intermediate points is situated between said first rotor minor circle and said first point on said first rotor major circle and another of said pair of intermediate points is situated between said first rotor minor circle and said second point on said first rotor major circle, said pair of intermediate points being circumferentially spaced from each other, and wherein said first rotor root line segments are defined by a pair of paths of said second rotor major point and said circumferentially-spaced second rotor major point when said first rotor major circle and said second rotor major circle rotate in phase with each other by equal angular amounts; and

identifying a pair of circumferentially-spaced first rotor line segments respectively extending between said pair of first rotor root line segments and said first point and said second point on said first rotor major circle.

106. The process according to claim 101, wherein steps (a)-(e) further comprise the steps of:

defining a first sealing relationship comprising a center, intermeshing sealing area according to geometries of a top land and a bottom land

defining a second sealing relationship comprising a front, outer sealing line according to geometries of a trailing face and a trailing ridge

defining a third sealing relationship comprising a front, inner sealing line according to geometries of a trailing edge and a trailing side,

defining a fourth sealing relationship comprising a back, outer sealing line according to geometries of said leading face and said leading ridge

defining a fifth sealing relationship comprising a back, inner sealing line according to geometries of said leading edge and said leading side;

defining a sixth sealing relationship by an intersection of trailing edge, trailing ridge and front cusp, wherein a front, outer sealing line and a front, inner sealing line define boundaries of a front, intermeshing sealing area between said trailing face and said trailing side and intersect at a common front sealing point;

defining seventh sealing relationship according to intersection of leading edge, leading ridge and back cusp; wherein said back, outer sealing line and said back, inner sealing line define boundaries of a back, intermeshing sealing area between said leading face and said leading side and intersect at a common back sealing point;

defining a eighth sealing relationship comprising a first peripheral sealing area according to geometries of female rotor major diameter and said cylindrical bores

defining a ninth sealing relationship comprising a second peripheral sealing area according to geometries of said top land and said cylindrical bores

defining a tenth sealing relationship comprising a center, non-meshing sealing area according to geometries of said female rotor major diameter and said male rotor minor diameter.

107. The process according to claim 101, wherein steps (a)-(e) further comprise the steps of:

selecting at least one of said male rotor circle and said female rotor circle;

defining a profile in two-dimensional coordinates relative to said selected rotor circle, said profile comprising a pair of points on said selected rotor circle, a first line segment offset radially inward from said selected rotor circle to a minor diameter, a second line segment connecting one of said pair of points to said first line segment, and a third line segment connecting another of said pair of points to said first line segment, wherein said pair of points are located on said selected rotor major diameter and comprise a first arc angle, wherein said first line segment and comprises a pair of end points, said pair of end points comprising a second arc angle less than said first arc angle, wherein said second line segment connects one of said pair of points to one of said pair of end points, and wherein said third line segment connects another of said pair of points to another of said pair of end points;

selecting at least one helix angle; and

defining at least one of a thread trailing face and a groove trailing side respectively according to at least one of said defined groove profile and said defined tooth profile, wherein said trailing face and said trailing side produce an intermeshing sealing area extending from one of said pair of intersection points to another of said pair of intersection points.

108. The process according to claim 101, further comprising the steps of selecting at least one helix angle and defining a figure-eight in close tolerance with said intersecting major circles.

109. The process according to claim 101, further comprising the step of repeating steps (a)-(e) to create at least one of a plurality of threads, another identical screw rotor device, and a family of screw rotors.

110. The process according to claim 101, further comprising the step of copying a profile resulting from steps (a)-(e) and creating at least one of a plurality of threads, another identical screw rotor device, and a family of varying sizes of screw rotors.